chamber when the candles went out." At such a time there would be about 19 per cent. of oxygen and 2·1 per cent. of carbonic acid in the chamber. No person had been in the chamber previously. "She stood five minutes perfectly well, and making light of the difficulty; but suddenly became white, and could not come out without help. She was remarkably healthy, never was ill, and was troubled with no fear of the air in which she stood."

From the air to the rain which falls through it, is but a single step; for if, as our author says, there is life and death in the air, we must believe the same of the rain, which collects the solids and liquids, gases and vapours which float about in the atmosphere. These ingredients of rain water can, indeed, be shown by chemical analysis; and by the microscope distinctions may be drawn between the air of various localities, without putting the health to the test. The author proceeds to describe his methods of testing rain water; but as the details of the scheme are mainly of interest to chemists, we must refer any curious readers to the book itself. Much of the work herein detailed was done years ago; long, indeed, before Pasteur had enlightened us as to the great reservoir of life which exists in our atmosphere. In 1852 Dr. Smith showed how complicated a fluid rain is. However carefully collected, albuminous bodies, the remains of living creatures, and minute animalculæ, may invariably be detected in it. "These creatures," says Dr. Smith—anticipating Dr. Frankland's aphorism, "Ohne Phosphor gar kein Leben"—"are sufficient of themselves to show the existence of phosphates, whilst sulphates and lime may be readily obtained. In examining the Thames water I often found that the readiest way of collecting phosphates and magnesia was to wait for the animalcules to do it."

Through the kindness of a number of gentlemen, Dr. Smith was enabled to make numerous collections of rain water from as far north as the Hebrides and as far west as Valentia. The results of the samples of the analysis may be thus briefly summarised:—The rain over the sea contains chiefly common salt, which crystallises clearly; but it also contains sulphates, and in larger proportion to the chlorides than is found in sea water. The amount of these sulphates increases inland before large towns are reached. They are to be regarded as the measure of the products of decomposition, the sulphuretted hydrogen from putrifying organic compounds becoming oxidised in the atmosphere. Within certain limitations, they may be taken as an index of the amount of sewage in the air. We accordingly find in the large towns the amount of the sulphates is greatly increased, owing to the combustion of the sulphur in coal, as well as the decomposition of organic matter contained in protein substances. When the sulphuric acid increases more rapidly than the ammonia, the rain-water becomes acid, and when the amount of this free acid reaches two or three grains in a gallon, or forty parts in a million, there is no hope for vegetation in a climate such as we have in the northern parts of this country. These free acids are not found with certainty where combustion or manufactures are not the cause. The amount of ammoniacal salts in the rain water increases with the number of towns in the district. This ammonia comes partly from the coal, and partly from the decomposition of albuminoid substances, which, indeed, may also be detected in the rain water. It is very interesting to compare the relative purity of the atmospheres of our cities and large towns, as determined by this method of air-washing. Upon the whole, that of London appears to be the best, and that of Glasgow decidedly the worst. Calling the amount of sulphuric acid in sea air 100, the average amount in that of London is 352, and in that of Manchester 513. In Glasgow the amount of ammonia is 150, in London it is 115; the amount of albuminoid ammonia in London air is only 109, whereas in Glasgow it is more than twice that amount, viz. 221. These analyses show unmistakably in what the evil of overcrowding consists; and it is with this subject on which he is thus led to speak that Dr. Smith closes his book. We commend his remarks to our City Improvement officials:—"Let those courts, alleys, and streets, which show the greatest mortality and the worst air, be destroyed or improved, without foolish mercy. There is a want of willingness to pull down dangerous property, but a readiness to rush forward to save the life of the greatest criminals. Reason is out of the question in the matter. We are misled by an uneducated feeling. We like to save property, forgetting that deadly weapons and poisons are subject to peculiar laws, and their indiscriminate use is forbidden to the nation. And houses that produce death are not property; as well might a man claim his debts as such. If a man sells unwholesome meat the law interferes; if he sells the use of a room with fever in it, the nation seems not to complain. Officers of health point out such places, but the public still refuse to destroy them, and great numbers are slain annually by legal methods, while strict methods are taken to prevent a few annually being killed by arsenic—a death more agreeable than the lingering misery in the lower parts of our crowded towns. I know that the lowest classes living in poisoned houses die from other causes than bad air; but I am speaking of air at present, and that is one of the causes. The time must come—and the sooner the better—when it shall be enacted that no land shall contain more people per acre than we know by experience in several places can live healthily thereon. The same thing must be said regarding houses, although these are more difficult for governments to deal with, because of the degradation of some of the population. Still the limitation must be attained, and for that we must strive."

T. E. THORPE

THE IRON AND STEEL INSTITUTE

THE Fourth Annual Provincial Meeting of the Iron and Steel Institute was held recently (August 6th to 9th inclusive) in Glasgow, under the presidency of Mr. Henry Bessemer, and it has been, if it were possible, even more successful than any of the previous reunions, furnishing thereby the best proof that such an association actually was a desideratum, and of the hearty co-operation which its establishment has called forth, from all interested directly or indirectly in the development of the Iron and Steel manufactures of Great Britain.

Since the three previous meetings were all held in the iron districts south of the Tweed, it is the more gratifying on this occasion to find that the first meeting of the Institution in Scotland should have turned out so eminently successful, and so marked by the hearty welcome with which Scotch ironmasters have received their Southern competitors in the trade; and it cannot but be observed that since the foundation of the Institute, a very different spirit has infused itself among the members of the iron and steel trades in general, as they no longer keep themselves jealously aloof from one another, but, on the contrary, are now pleased to meet, and in a spirit of generous rivalry to interchange their ideas, thereby to some extent, at least, tacitly acknowledging that the advancement of industry of the country at large, so far from being prejudicial to, is in reality ultimately connected with, the interests of each individual manufacturer also. It is the recognition of this principle which has enlisted the sympathies of those engaged in the iron and steel industries, and has contributed so much to the success of the Institute, which at this moment, including those candidates nominated at the present meeting, numbers no less than 602 members—a surprising result when it is remembered that the Association is now only in the fourth year of its existence.

The Glasgow meeting of the Institute commenced on Tuesday, August 6th, when its members assembled in the Corporation Galleries, Sauchiehall Street, which had most liberally been placed at the disposal of the Council of the Institute by the Lord Provost and Magistrates of the City; the proceedings being prefaced by a short introductory address from the President (Mr. Bessemer), together with a few words of welcome from the Lord Provost of Glasgow.

The Secretary then announced that the Council had recommended Mr. Isaac Lothian Bell, of Newcastle, as president-elect, and nominated Mr. Edward Williams, of Middlesborough, as vice-president in the place of Mr. Bell, as also Messrs. W. S. Roden, C. W. Siemens, H. Sharpe, W. Nielson, and J. Hunter to the vacancies caused by the retirement of the other members of the Council by rotation, which recommendations were unanimously adopted by the meeting.

The Foreign Secretary read out the names of those gentlemen connected with the foreign iron trade then present at the meeting, amongst whom were representatives of France, Belgium, Germany, Sweden, and the United States of America.

The election of members was then proceeded with, after which an extremely interesting paper, "On the Coal and Ironstone Strata of the West of Scotland," was read by Mr. James Geikie, of the Geological Survey, in which a general sketch of the geology of the district, with special reference to the occurrence and nature of the coal and ironstone deposits, was given in a concise yet extremely lucid communication, the delivery and discussion of which occupied the remaining available time of this day's meeting. Visits were subsequently made by the members to some of the neighbouring works, and more particularly to the Blochairn Iron Works, where considerable attention was paid to Mr. Graham Stevenson's new mode of reversing rolling mills then in operation.

On the following day (Wednesday) the meeting commenced at 10.30 A.M. by the reading of a paper by Mr. J. F. Mayer, of Glasgow, "On the Rise and Progress of the Iron Manufacture of Scotland," which was an historical sketch of the subject, commencing from the year 1760 when iron was first smelted at Carron, near Falkirk, and continuing it down to the present time, when the Scotch iron manufacture occupies so prominent a position in the British iron trade. Attention was specially directed to such improvements in the manufacture of iron as had originated in this part of Scotland, amongst which were mentioned the use of raw coal instead of coke in iron smelting by Condie at Govan, the employment of hot blast by Nielson, and the utilisation of the black band ironstone by Daniel Mushet, discoveries which, it may be said, were the making of the Scotch iron trade.

The next two communications related to the different systems for reversing the rolls in rolling wrought iron; the first of these by Mr. J. D. Napier, "On Napier's differential gear for reversing rolling mills," illustrated by models, described the application at the Codnor Park Iron Works in Derbyshire of a differential clutch, identical in principle with the differential breaks used by him in the windlasses of ships; whilst the second, by Mr. Graham Stevenson, "On Reversing Rolling Mills," advocated the employment of his conical clutch, which had been inspected the previous afternoon at the Blochairn Iron Works. These two papers were discussed together, and gave rise to a very animated debate, in the course of which much valuable information was elicited from the observations made by members practically acquainted with the subject. The balance of opinion appeared, however, to be in favour of Mr. Napier's differential clutch, the extreme simplicity of which appeared to give it advantages over any hitherto applied form of reversing gear, not excluding the conical clutch of Mr. Stevenson, which, nevertheless, was admitted to work very satisfactorily.

The meeting then broke up, most of the members proceeding by a special train to inspect the Iron Works at Gortsherrie, Coatbridge, Summerlee, and Monkland. Amongst the novelties examined on this excursion may be mentioned the new coal-cutting machine, invented by Messrs. Miller and Anderson of Coatbridge, then at work in the No. 3 pit, Gortsherrie, belonging to Messrs. William Baird and Co.

This machine is stated to cut 350 ft. of coal per shift of 8 hours, yielding 75 tons, or equal to the united turn out of 40 men, whilst it only requires two to attend to it, being driven by compressed air at a pressure of 45 lbs. to the square inch, brought in cast iron pipes some 300 fathoms from the shaft. As six additional machines are in course of construction for Mr. Baird, it is evidently regarded as a success; and it is hoped that in these days of incessant strikes it may prove capable of doing all it is represented to do, and thus be the means of checking in some degree the exorbitant demands of the colliers.

At the North British Iron Works, at Coatbridge, M. Dormoy's patent puddling furnace, with revolving rabble, driven by steam power, was shown in full operation, and appeared to elicit the very general expression of opinion that the invention, even if ingenious and practical, had come out too late in the day. Now that the more perfect system of rotary puddling of Mr. Danks has proved successful in dispensing with the labour of the puddler altogether, it is not likely that the ironmaster of the future will be content with a system which at best is only an improved manual process for puddling iron.

At the Monkland Iron and Steel Works the interest of the visitors was concentrated in inspecting the two blast furnaces constructed on Ferrie's patent coking principle. These furnaces have a height of no less than 90 ft., and are so arranged that, when fed at the top with the raw coal and iron ore mixed together, the coal, as it descends, becomes coked in the upper portion of the furnace, before it reaches the smelting region of the furnace lower down. Great economy in fuel is claimed for this arrangement; it being considered that the heat and combustible gases driven off and lost, when the coal is previously coked as at present in separate coking ovens or heaps, are utilised entirely in the Ferrie blast furnace.

The favourable opinion expressed by several of the members of the Institute, will, it is understood, lead to the erection of several of these furnaces, both in the district and probably in England also.

The meeting on Thursday commenced at 10.30 A.M., and was opened by the reading of a paper by Dr. A. K. Irvine, of Glasgow, "On a new miner's safety lamp," in which the author described an invention of a most ingenious character, which is likely to prove of great service in coal mines troubled with explosive gases, since, besides serving the purpose of an ordinary safety lamp, it sounds a note of warning to the workman the moment the air around becomes so charged with firedamp as to be dangerous or explosive. The principle of the lamp is based on the fact that when a mixture of any inflammable gas or vapour, with air in explosive proportions, is lighted on the surface of wire gauze, having meshes sufficiently small to prevent the passage of flame, and a suitable tube or chimney is placed above, so as to prevent admission to the chimney except through the wire gauze, a musical sound is produced varying in pitch with the size of the flame and dimensions of the chimney.

A number of interesting experiments were exhibited to illustrate this principle, and various miner's lamps as constructed were exhibited and tested in mixtures of air with ordinary coal gas, when they at once indicated the danger as soon as the atmosphere by which they were surrounded contained sufficient gas to be dangerous, by emitting a strong clear sound like that of a horn, which could be heard at a considerable distance. Another form of this lamp was also shown, intended to be employed as a stationary warning apparatus or alarum after being placed in any part of the mine considered likely to ensure the safety of the workmen, so that it might sound the danger signal before the air around it was so far charged with fire-damp as to become explosive. The novelty and importance of such an invention were apparent to an audience of practical men; and besides passing a cordial vote of thanks to the inventor, arrangements were made for at once fully testing its merits by its practical employment in some English collieries noted for fire-damp.

After an interesting paper by Mr. D. Rowan, of Glasgow, "On the rise and progress of the iron ship-building trade in Scotland," which, however, was of a purely historical and statistical nature; the next communication was made by Mr. Lauth, of Pittsburg, United States, "On Lauth's system of rolling iron by three high rolls." The improvements proposed in this system of rolling, which is in itself very old, consisted in making the central roll of less diameter than the two others, which are of ordinary size, and in having it fixed, whilst the two others are adjustable by screws. In the hard rolls the bottom roll alone is driven, both the middle and top roll being carried round by friction. All expansion or contraction is prevented by a stream of water constantly kept running on to the roll; and great rapidity in rolling, as well as economy in labour, is claimed for this system. In the discussion which followed, the general opinion appeared to be that, although such rolls were well adapted for plates, in this country they were less adapted for rail rolling, owing to the greater difficulty in adjusting the grooves so as to turn out rails as correct in section as was insisted upon by our and most of the Continental engineers, but not in the United States; also because the necessity for three rails would still further augment the immense stock of rolls requisite to suit the multiplicity of sections required in the English trade, as well as increase the labour and time required in changing the rolls.

The next paper was by Mr. A. Spencer, of West Hartlepool, "On further improvements in Spencer's Rotary Puddling Furnace" a model of the furnace in its present form being exhibited, and its construction, mode of fettling, and working, fully entered into by the author; after which, owing to time not permitting, a lengthy paper by Mr. J. Guildford Smith, of Philadelphia, "On the Westward development of the Iron Manufacture of the United States," was taken as read; and after passing votes of thanks to the Lord Provost and civic authorities of Glasgow, the Council of the Philosophical Society, the Committee of the Royal Exchange, the local Committee, and the President of the Institute, the proceedings of the meeting were brought to a close.

In the afternoon an excursion was made by a special train to the Coltness and Mossend Ironworks, the members of the Institute being entertained on their return at a banquet given in the Corporation Galleries by the local Committee of the Institute.

An interesting feature in connection with the meeting was the arrangement of a temporary museum in the Corporation Galleries containing models, specimens, and objects of all kinds bearing more or less directly on the Iron and Steel manufacture, many of the articles exhibited being of great interest.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Solar Outbursts and Magnetic Storms

IN the French *Comptes Rendus* of August 4, which has lately reached this country, is an account by Father Secchi of a remarkable outburst from the sun's limb witnessed by him on July 7, which lasted from $3^h\ 30^m$ to $6^h\ 50^m$ (Roman time, I presume), or nearly $2^h\ 40^m$ to $6^h\ 0^m$ (Greenwich time).

A magnetic storm commenced at Greenwich at $5^h\ 0^m$ precisely on the same day. Its indications began at that time with unusual suddenness and strength, on all the magnetic indicators, namely the declination-needle, the horizontal force magnetometer, the vertical force magnetometer, the earth-current wire, in an approximate N.E. and S.W. direction, and on the earth-current wire in an approximate N.W and S E. direction. The disturbance lasted, gradually diminishing, to the evening of July 9. During a part of the time it was accompanied with aurora.

I do not venture upon the question whether there really was any connection between the solar outburst and the terrestrial magnetic storm, but I will remark that, if there was such connection, the transmission of the influence from the sun to the earth must have occupied $2^h\ 20^m$; or a longer time if Father Secchi did not see the real beginning of the outburst. This, if established, would be an important cosmical fact; and, at any rate, the notification of this apparent retardation may direct the attention of observers of similar phenomena in future to a new element in their interpretation.

G. B. AIRY

Royal Observatory, Greenwich, August 14

Ocean Circulation

ALTHOUGH no mathematician, and only an amateur in physics, it appears to me that the difficulties and objections of Mr. Croll on this subject may be obviated, and the whole question elucidated by a reference to the admitted facts, and a common sense interpretation of them. And first, as to the fact that the surface water of the Atlantic Ocean, in moving northwards from the equator to 60° lat., has almost wholly lost the easterly motion of rotation it should have brought with it. This loss is imputed by Mr. Croll to friction only, and he argues that the much lower velocity of the northward current must, therefore, be wholly neutralised by friction. This is his main argument, which he has repeatedly adduced, and to which he has hitherto received no reply. But, although his reasoning might be admitted if the conditions affecting the two motions were the same, it seems to me to be quite inapplicable to the present case. If, in the temperate zone, the ocean extended uninterruptedly in an east and west direction round the globe, it would no doubt retain a considerable portion of the equatorial eastern motion, and whatever deficiency existed might fairly be imputed to friction. But the Atlantic is actually like a huge lake, with continuous eastern and western shores, and the water which flows northwards along the eastern shore is prevented from moving eastwards, not by friction against water or even against the shore, but by having to perform work in lifting or heaping up the water against the shore, just as the water of a pond or lake is heaped up on the leeward side by a strong wind. As the direction of the motion of the water will, however, by the hypothesis, be oblique or somewhat north of east, some of the motion will be diverted northwards along the eastern shore, and thus tend to increase the northerly flow. The 9,925 pounds of energy (according to Mr. Croll) are not therefore consumed in overcoming the frictional resistance to eastward motion, but for the most part in doing the actual work of overcoming gravitation and holding up the waters at a higher level, and the theoretical amount of this rise can, no doubt, be easily calculated for us by Mr. Croll.

The case of the water moving northward is very different.